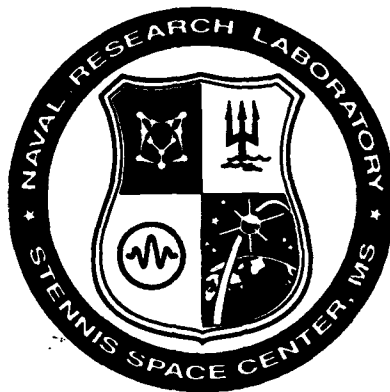AD-A254 022

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U.S. Navy-ASEE Summer Faculty Research Program

Abstracts 1987-1991

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FOREWORD

The U.S. Navy-American Society for Engineering Education (ASEE) Summer Faculty Research Program provides science and engineering faculty members from colleges and universities the opportunity to participate in research at Navy laboratories for a ten week period during the summer. The primary concept of the summer program is to create opportunities for faculty members and laboratory scientists to work together in mutual interest research projects.

Participants have an opportunity to establish continuing research relations with the personnel of the host laboratories which may result in sponsorship of the participants' research at their home institutions. Professional contacts are expanded. Laboratory, computational and specialized library facilities on a scale not available at some universities and colleges can be used to conduct research which might otherwise be impossible.

Objectives of the program are (1) to engage university faculty members in the research programs of the various Navy laboratories; (2) to develop the basis for continuing research of interest to the Navy at the faculty members' institution;(3) to establish continuing relations among faculty members and their professional peers in the Navy; (4) to enhance research interests and capabilities of science and engineering faculty members.

This report contains an abstract for each of the research projects conducted by summer faculty participants at the Naval Research Laboratory Stennis Space Center from 1987-1991.

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VARIATIONAL MODEL FOR A BUBBLY LIQUID
WITH A DISTRIBUTION OF BUBBLE SIZES

Anthony Bedford

Department of Engineering and Engineering Mechanics
University of Texas
Austin, Texas

Abstract

The presence of a small amount of gas bubbles in a liquid or sediment substantially alters the acoustic properties of the material. In 1983 Bedford and Stern presented a variational model for the acoustics of a porous medium saturated by a bubbly liquid in which it was assumed that the bubbles were of uniform size. In any natural situation, such as an ocean sediment containing bubbles of gas, the bubbles will exist in a distribution of sizes. In order to extend the model of Bedford and Stern to a porous medium saturated by a bubbly liquid with a distribution of bubble sizes, a study has been undertaken to develop a variational formulation for the acoustics of a bubbly liquid with a distribution of bubble sizes. A distribution function was introduced which specified the number of bubbles per unit volume as a function of the bubble radius. Following Bedford and Stern, Hamilton's principle was used to obtain the equations governing the mixture. Equations were obtained which predicted the phase velocity and attenuation of acoustic waves in the bubbly liquid for an arbitrary distribution function. The results agreed with those recently obtained by Prosperetti and Commander (1988) using a different approach.

Research Colleague at NORDA: J. Matthews

(Bergeron, 1988)

DEVELOPMENT OF DATA ANALYSIS TECHNIQUES FOR AEM BATHYMETRY

Clyde J. Bergeron

Department of Physics
University of New Orleans
New Orleans, Louisiana

Abstract

This work falls in two general categories: (1) application of Bergeron's Modified Image Method (MIM) to the analysis of AEM data, and (2) the implementation of Sengpiel's equivalent half space inversion method. The MIM applications include (a) development of approximate signal signatures produced by 2-D and 3-D conducting features such as ice keels and submerged conducting structures, (b) extending the frequency range of the MIM inversion algorithm to lower frequencies, and (c) the development of a MIM inversion routine for the difference of AEM fields measured at two frequencies. In Sengpiel's equivalent half space inversion, both the apparent half space resistivity $\underline{a}$ and the depth of the half space current centroid Z^* depend on the system altitude $\underline{h}$ at which the data is calculated or measured. This produces the problem of distinguishing between geology and bird elevation as the source of the lateral variation in $\underline{a}$ and Z^*. A method of analytic continuation has been developed which transforms data taken over a survey line at varying altitudes into an equivalent data set at a fixed altitude, thereby better delineating the changes in the data due to lateral variations in the geology. This should tend to remove the ambiguities in Sengpiel's analysis produced by variations in the bird's altitude over the course of a survey line.

Research Colleague at NORDA: K. Smits

(Braza, 1991)

STOCHASTIC OPTIMIZATION OF A REDUCED DIMENSIONAL SPACE
IN MATCHED FIELD PROCESSING

Peter A. Braza

Department of Mathematics and Statistics
University of North Florida
Jacksonville, Florida

Abstract

Matched field processing is sensitive to environmental mismatch. Collins and Kuperman recently considered a technique in which environmental parameters were included in the search space. The approach considered here is one in which a subset of the horizontal wave numbers are included in the search space instead of parameters which are explicitly physical in nature. The range and distribution of each wave number are determined by physical considerations. The reduced dimension of this approach enables one to search the space efficiently while capturing the net effects of the environment. The extrema of an effective cost function is found by utilizing the optimization method of simulated annealing.

Research Colleague at NOARL: G. Smith

(Dean, 1991)

SOURCE LOCALIZATION IN MATCHED-FIELD PROCESSING

E. Alan Dean
Department of Physics
University of Texas at El Paso
El Paso, Texas

Abstract

Matched-field processing is sensitive to mismatch of acoustical environment. Source focalization localizes the source in space and focuses the source by perturbing acoustical parameters. Realistic focusing by simulated annealing requires efficient algorithms. Efficient localization depends on the quasi-separation of depth and range, which is complicated by lack of knowledge of the polarity of the mode eigenfunctions. A new heuristic approach to the separation of range and depth first determines the "best" depth without regard to polarity by a minimization process involving only the diagonal elements of the cross-spectral matrix in mode space. This fixes the polarity of the eigenfunctions, which is used to improve the depth determination. Next a minimization process involving only the nearest off-diagonal elements of the matrix determines the "best" range.

The method, believed to be more efficient than that of Shang (1989), is used to localize a real-data course (Feuillade, et al, 1990) using Pekeris eigenfunctions and eigenvalues. The result agrees with that obtained by a search of the whole range-depth space that required more computation.

Research Colleagues at NOARL: G.B. Smith and C. Feuillade

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(Drost-Hansen, 1990)

HIGHLY ANOMALOUS TEMPERATURE EFFECTS ON HINDERED SETTLING AND COMPACTION OF KAOLINITE SUPENSIONS

Walter Drost-Hansen

Department of Chemistry
Laboratory for Water Research
University of Miami
Coral Gables, Florida

Abstract

The rates of hindered settling (and the early states of compaction) of kaolinite in suspension have been measured as a function of temperature over a wide range of temperatures at closely spaced intervals. It appears that these are the first such experiments to be reported on the temperature effects on sedimentation. The main conclusions drawn from these experiments are: 1. Temperature strongly affects the rates of hindered settling of kaolinite (10 and 20% in 36 ppt seawater and distilled water). 2. Typical settling curves show distinct minima at those temperatures (T(k)) where vicinal (i.e., interfacially modified) water is known to undergo structural transitions (the "Drost-Hansen (thermal anomaly) temperatures"); Drost-Hansen, 1969. 3. The rate of compaction, in the early stages of this process, is also strongly influenced by temperature. However, in the case of compaction the rate goes through a maximum near T(k) instead of a minimum as observed for the hindered settling. 4. When the compaction is complete, or nearly complete, the relative volumes of the sediments formed increase with increasing temperature. The (apparent) thermal expansion is about 0.2% per C, - i.e., far higher than the thermal expansion coefficient of bulk water (0.026 % per C) or the clay (0.06 % per C). 5. The pronounced effects of temperature observed in this study are totally unexpected based on "classical" theories of colloidal behavior! However, the effects are readily interpreted, at least qualitatively, in terms of the vicinal water structure concept (Drost-Hansen, 1971, 1973, 1976, 1979, 1983, 1990). 6. As all properties of vicinal water measured so far differ from the corresponding bulk values it follows that estimates of the properties of natural sediments cannot be obtained simply on the basis of knowing the mineralogy and the bulk properties of water (or seawater). Among the properties (of interest to the Navy) most likely to be affected by the presence of vicinal water are densities, specific heat, thermal expansion coefficient, isothermal and adiabatic compressibility (and thus also the geoacoustic properties), thermal and electrical conductivity, permeability and mechanical strength of the sediments.

Research Colleague at NOARL: R. Bennett

5

(Dubroff, 1987)

ANALYSIS OF HIGH FREQUENCY ARCTIC ACOUSTIC DATA

Richard E. Dubroff

Electrical Engineering Department
University of Missouri, Rolla
Rolla, Missouri

Abstract

A set of experimental data, recorded beneath a layer of arctic ice, had been acquired in 1986. Although the data analysis had already begun, the purpose of the present work can be categorized as analyzing the current data analysis methods and, wherever possible, suggesting and implementing improvements. In order to provide a control data set, a special purpose ray tracing program was written and used to synthesize the data which would have been acquired under known conditions. Interfacing programs were also written in order to allow the synthetic data to run through the same data processing flow as is used for the real data.

The estimation of the maximum normalized cross coherence between pairs of acoustic signals was one of the major objectives of the data analysis. An approach based upon the Hilbert transform seemed to improve the results over some of the earlier estimates based upon guadrature sampling. An additional approach based upon successive interpolation of the data was coded but has not yet been evaluated.

A deconvolution program was written in order to separate the direct and under-ice reflected signals. This program was checked through the use of synthetic data (from the ray tracing program) and is now being evaluated with experimental data.

Research Colleagues at NORDA: J. Posey and M. Wilson

DATA REDUCTION AND PROCESSING
OF ARCTIC REFLECTION RECORDS

Richard E. DuBroff

Electrical Engineering Department
University of Missouri
Rolla, Missouri

Abstract

Randomness of the water-ice interface beneath ice floes in the Arctic Ocean imposes a corresponding randomness upon the acoustic waves scattered by this interface. Furthermore, as the scattered acoustic waves propagate to ever greater depths, combining in phase at some points and out of phase at others, the properties of the propagation medium (the sea) exert an influence upon the scattered waves.

In an effort to separate the randomizing effects of rough surface scattering from the deterministic effects of wave propagation, it is convenient to regard wave propagation from one depth to another as a form of linear filtering in which the input (consisting of the scattered acoustic wavefield at one depth) is convolved with a known function (representing wave propagation) to produce an output (the scattered acoustic wavefield at a different depth). Inasmuch as acoustic waves are events which vary in both space and time, the convolutions are multi-dimensional integrals rather than the single fold time domain integrals which occur in conventional system theory.

The transfer function, a mathematical model of the linear filtering process as the wave propagates from one depth to another, also can model the depth variation of statistical measures of the scattered acoustic wavefield (e.g., cross power spectra, cross correlations). In fact, when the statistical measure is characterized by a small number of free parameters (for example, a linear combination of known functions), the transfer function can be used to tie free parameters to experimental observations thereby providing a system of equations which, in turn, determines the numerical value (values) of the free parameters. Computer programs, designed to perform this calculation, have been written and checked with simulated data. The programs have not been tried with real data.

Research Colleague at NORDA: J. Posey

(Duggin, 1989)

STUDIES OF FACTORS AFFECTING SIGNAL-TO-NOISE RATIO
IN DYNAMIC CLUTTER BACKGROUND: OPTIMIZATION OF TARGET DETECTION
USING IMAGE PROCESSING TECHNOLOGY

Michael Duggin

Forest Engineering Department
State University of New York
Syracuse, New York

Abstract

During this summer, activities have consisted of studies of clutter, target detection, and recognition in temporal sequences of sea surface images. Digital image analysis techniques have been used to develop a methodology to synthesize images of the sea recorded by sensors with various noise characteristics, consisting of more than one channel, subject to various levels of jitter and containing targets of various pre-determined luminescence, size, and morphology.

Starting with a sequence of images of the ocean obtained at 30 frames a second and with a surface resolution of about 3m. The images were corrected for vignetting and studies were made of the power spectra for each image and of the statistical distribution of image picture element (pixel) brightness values. It was found that the pixel brightness frequency histograms of the sequency were time-dependent and appeared to follow Poisson, rather than Gaussian statistics, contrary to what current theory had supposed to be the case. The time-dependence of the sea surface power spectrum will introduce variation in the detection probability and in recognition performance based upon spatial criteria.

A modelling capability for introducing sensor noise and jitter for a two-channel scenario was developed, and the impact of jitter displacement on signal-to-noise ratio was determined for various jitter displacement levels. The direction of jitter displacement relative to the direction of wave crests was found to be significant.

Studies of more than one sea state and target were performed. Three papers with colleagues at NORDA are currently in preparation as a result of this work.

The first two Stokes parameter images of the earth and oceans obtained from Space Shuttle (STS-S14), studied in cooperation with NASA, were further analyzed while at NORDA in order to ascertain the temporal behavior of power spectra of sea surface.

Research Colleague at NORDA: R. Holyer

(Faas, 1988)

RHEOLOGICAL PROPERTIES OF CONCENTRATED SEDIMENTARY SUSPENSIONS

Richard W. Faas

Department of Geology
Lafayette College
Easton, Pennsylvania

Abstract

Research focused on determining the rheological behavior of dense suspensions of fine-grained sediments, commonly found as on intermediate layer between the overlying water and the permanent bottom in muddy estuaries and turbid coastal environments. These suspensions range in density between 1.03 and 1.30 Mg/m^3, corresponding to sediment concentrations between 10 to 480 g/l. Suspensions were generated from bottom samples from Panama City, Florida, the western portion of Mississippi Sound, and the foreset beds of the Mississippi Delta. Slurry samples at three different densities were analyzed in a rotational viscometer to determine density-dependent viscous effects.

Various forms of non-Newtonian viscous behavior were observed. Mississippi Delta muds showed only pseudoplastic (shear thinning) flow behavior at shear rates between 0.61 and $122.36s^{-1}$. Panama City muds exhibited along internal of Newtonian to dilatant (shear thickening) flow between shear rates of 0.61 to 6.12 s^{-1}. Flow behavior of Mississippi Sound muds changed gradually from shear thinning to shear thickening through a long shear rate interval (0.61 to 6.12 s^{-1}) as their densities increased beyond 1.150 Mg/m^3. They resembled the flow behavior of the Panama City samples but were significantly less viscous at comparable densities and showed wide variation. "Apparent" viscosity (measured at $3.05s^{-1}$) of the Panama City muds increased linearly with density, reaching 160 Pa.s occurring at 1.18 Mg/m^3. Mississippi Sound muds also show a linear relationship between "apparent" viscosity and density which corresponds with the Mississippi Delta muds; however, the data appear less well-correlated. Yield stress correlates well with density in both the Panama City and Mississippi Delta samples, occurring at lower densities in the Panama City sample (400 Pa at 1.09 Mg/m^3). In Mississippi Sound, yield stress seldom exceeded 150 Pa.

Tentative conclusions are: 1) Mississippi Sound sediment will be easily resuspended due to low yield stress and shear thinning flow behavior at low densities. 2) Panama City mud will resuspend with difficulty due to yield stress development at low densities and shear thickening flow behavior. 3) Mississippi Delta mud will be difficult to resuspend if allowed sufficient time to develop high (>1.150 Mg/m^3) densities but will likely move as a coherent mass due to shear thinning flow behavior.

Research Colleague at NORDA: R. Bennett

(Full, 1990)

QUANTITATIVE APPROACHES FOR ARCTIC IMAGE ENHANCEMENT

William E. Full

Department of Geology
The Wichita State University
Wichita, Kansas

Abstract

There are many problems which can arise in the analysis of satellite and airborne
images which require the scenes to be pre-processed in order to remove undesired
effects. The failure to deal with problematic images can limit the usefulness
of expert systems that have been designed to extract meaningful information.
Mathematical tools can be designed, and are generally available, that can enhance
to information derived from these expert systems when problematic scenes are
encountered.

One type of problematic data is when the average background pixel intensity
varies across a scene. This type of scene is not uncommon in the visual spectra
(also with some other wavelengths) where either the sensor is at an oblique angle
at nadir, or the intensity declines as a function of earth curvature as seen in
many arctic images. Trend surface analysis, a technique tool that fits the
background intensity values with mathematical surfaces defined by polymodal
equations, has been found useful for this type of data. Polynomials of order 3
and 4 have been found to be reasonable for the analysis of fractures in polar ice
studies. This procedure can be made more "expert" by incorporating fuzzy
variables and options that can be used to exclude regions from being defined as
background in the mathematical analysis.

Other techniques, such as Wiener type filtering, have been shown to be successful
in removing relatively high frequency noise from images that reflect extremes of
detection. One such case arises in the analysis of passive microwave images used
in arctic ice studies. This technique has the promise of additional application,
especially as a data pre-processing algorithm, as it represents a mathematical
approach which can be used in an unbiased mode, as when dealing with random
noise, or can be biased by additional information such as a preferred model or
when several wavelengths are available for analysis.

Other possible pre-processing approaches explored to various degrees included the
use of principle component analysis, linear unmixing analysis, double Fourier
analysis and filtering, and techniques involving non-parametric statistics. The
usefulness of these approaches awaits completion of further studies.

Research Colleague at NOARL: D. Eppler

(Full, 1991)

SPECIALIZED IMAGE ANALYTIC TECHNIQUES FOR REMOTE SENSING
OF ARCTIC ENVIRONMENTS

William E. Full

Department of Geology
The Wichita State University
Wichita, Kansas

Abstract

Algorithms for the processing of remote sensing data are found commonly in commercial software and hardware packages. For the most part, these algorithms perform well and have been incorporated into unsupervised systems. There are, however, instances in which more specialized algorithms are needed. These instances arise in situations where the extraction of information from a particular image is functionally related to global or regional variation in pixel intensities, amount of global or regional contrast reflected by the individual features of interest, or obscuration by effects such as cloud-cover.

Algorithms that identify information via global or regional pixel intensity differences such as those used commonly to identify Arctic leads in AVHRR images, are particularly susceptible to regional variation in the surface temperature field, illumination, and cloud-cover. The linear trend-surface algorithm has been an efficient method for correcting regional background intensity variation in images with relatively uniform lead intensity and no obscuring cloud-cover. Under the most ideal circumstances, the fourth order surface produces an adequate correction. Ideal circumstances, however, are not commonplace as clouds are normally present and lead density is rarely uniform.

An attempt at defining algorithms for the non-ideal images was undertaken. The general philosophy of the approach is to use only the regions of the image that could be definitively identified as leads, decompose the background pixels from the leads using fuzzy-clustering techniques, and finally, use the background values as input into the linear trend-surface correction algorithm. For the lead versus non-lead classification scheme, identification of regions with leads involves the use of gradient operators, maximum entropy optimization, and linear discrimination techniques. Areas of study that need further work include: 1) determination of the optimal size of the regions used in the classification scheme, 2) inclusion or non-inclusion of additional information derived from larger gradient operators, 3) determination of the success of the classification scheme over a larger number of images, 4) optimal choice of fuzzy clustering parameters including fuzzy exponent, variety of cluster, and degree of clustering, and 5) criteria used to make the proper choice of optimal order to trend surface. Preliminary results suggest that this approach is promising and might be conductive for expert system implementation.

Research Colleague at NOARL: D. Eppler

(Gray, 1987)

CONVERSION OF ELLIPTICAL COORDINATES
WITH THE ACCOMPANYING COMPUTER PROGRAMS

Lou Allen Bell Gray

Department of Mathematics
Jackson State University
Jackson, Mississippi

Abstract

The purpose for using elliptical coordinates is to provide a coordinate system for the ship and receiver in acoustical wave propagation studies in the ocean. The position of interest for this study is at the point of focus. For this study, the ship would be at one focus point and the receiver would be at the opposite focus point.

One of the assumptions about the system is that the distance from each of the focus points to a designated point on the ellipse is known. The elliptical coordinates are restricted in the values which they can assume when defining x and y in the regular cartesian system. When confocal ellipses are examined, there is a restriction on ϵ (one of the elliptical coordinates). When changing from elliptical coordinates to x and y coordinates, there is a restriction on η (one of the elliptical coordinates). All computations require knowledge of the value of the distance from the center of the ellipse to a focus point. Some computer programs have been drafted to perform some changes between coordinate systems. The computer programs are written in basic Fortran. The computer programs have not been checked for bugs.

Research Colleagues at NORDA: J. Caruthers and C. Wilcox

(Greene, 1990)

CLASSIFICATION OF UNDERWATER ACOUSTIC TRANSIENTS
BY ARTIFICIAL NEURAL NETWORKS

Ronald L. Greene

Department of Physics
University of New Orleans
New Orleans, Louisiana

Abstract

The problem of classifying received underwater acoustic transients according to source type has been investigated using artificial neural networks. Tests of several types of preprocessing of time sequences indicated that Fourier transform magnitudes of the entire signal and portions of it could be used to successfully train and test the neural networks.

Nearest-neighbor and backpropagation networks were training to correctly classify 10 different preprocessed model source signals. They were then tested on signals propagated by the time-domain parabolic equation model to 25 different receiver sites. Despite the interference effects from surface and bottom reflections, the classification accuracy for both types of network was found to be about 90% in an idealistic, noise-free case. Results for noise-to-peak signal ratios up to about 0.1 are nearly the same. Larger noise ratios show significant reduction in accuracy; however, the redundancy provided by the multiple receivers in nearly all cases allows the networks to correctly classify all the signals from sources on which they were training. The backpropagation-trained network shows a robustness in the presence of unknown signals not shown by the nearest-neighbor network.

Research Colleague at NOARL: R. Field

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(Hsieh, 1987)

MEASUREMENT OF LIQUID SURFACE ACOUSTIC WAVE AMPLITUDES

Shieh-Tsing Hsieh

Electrical Engineering Department
Tulane University
New Orleans, Louisiana

Abstract

This research work on the measurement techniques of acoustic wave amplitudes over liquid surfaces using lasers is a continuation of a research project initiated in 1986 at NORDA's Optics Laboratory. A simple theory of optical-acoustic interactions that an acoustically excited liquid surface may produce an amplitude modulation in the probing laser beam was developed. The theory of operation for the homodyne and heterodyne detections were re-examined. Based on a piece-wise linear response model of photomultipliers, the optimum conditions for detections were established. An optical system with a low power HeNe laser, a cooled photomultiplier, and a water tank using standard Navy transducers was used for the experimental study. In order to enhance the detection of the small amplitudes of the liquid surface acoustic waves, specially designed amplifiers and a PC microcomputer data acquisition system with ASYST based signal processing software were assembled. Based on the theoretical result of homodyne detection of amplitude modulations and experimental data, the measured wave amplitudes on the acoustically excited liquid surface were estimated to be in the order of nm in the frequency range of 5 to 23 Khz. The success of the homodyne detection of amplitude modulation due to liquid surface acoustic wave can be used as an independent calibration method for the heterodyne detection of frequency modulation induced by the surface acoustic wave due to Doppler effect.

Research Colleague at NORDA: G. D. Hickman

(Hsieh, 1988)

OPTICAL PROBES FOR REMOTE SENSING WATER SURFACE AND SUBSURFACE PROPERTIES

Shieh-Tsing Hsieh

Electrical Engineering Department
Tulane University
New Orleans, Louisiana

Abstract

Part I. Laser optical probes using HeNe laser utilizing Amplitude Modulation (AM) principle, homodyne principle, and heterodyne principle were set up in the NORDA Code 352 Optics Laboratory in a non-magnetic environment for determining underwater acoustic waves. The AM and homodyne probes used a cooled photomultiple take as the detector, which is extremely sensitive but very noisy. The heterodyne probe used a solid state detector which is very stable and immune to radio-frequency interference. But the heterodyne operation requires a laser with extremely long coherent length, and a stabilized HeNe laser has been ordered for this purpose.

Part II. Use of laser Raman and Brillouin scattering spectroscopy for profiling water properties is studied, and it is found that the emergence of better detectors may overcome many of the previous problems; conceptual design and approach from laboratory to field tests were accomplished.

Research Colleague at NORDA: G. Hickman

(Ioup G, 1987)

NONORTHOGONALITY OF MEASURED MODES IN SHALLOW WATER AND PERFORMANCE EVALUATION OF SINUSOIDALLY DEFORMED LINE ARRAYS

George E. Ioup

Department of Physics
University of New Orleans
New Orleans, Louisiana

Abstract

The importance of surmounting the nonorthogonality of measured normal modes and processing shallow water data in such a way that modal compositions are effectively recovered for matched field processing has been demonstrated by several investigators. The potential for improvement using this technique is greatest when the nonorthogonality of the measured modes is largest. The Helmholtz equation for the Pekeris model is cast in dimensionless form and studied to learn the amount by which the normal modes fail to be orthogonal for a variety of ocean bottoms, array lengths and discretizations, and array positions. Environments are selected to reflect sediment types characteristic of the continental shelf using an inverse linear relationship which is shown to exist between water-to-bottom density and velocity ratios for the data of Hamilton. The results indicate that nonorthogonalities are greatest for water depths and frequencies at and just above modal onsets, for sound speed ratios close to one, and for arrays which span only a small fraction of the water column. This work has been performed with Grayson H. Rayborn, Juliette W. Ioup, Donald R. Del Balzo, and Christopher Feuillade.

A manuscript has been prepared titled, "Performance Evaluation of Sinusoidally Deformed Line Arrays" with Deanna M. Caveny, Donald R. Del Balzo, and James H. Leclere. Deformations of towed arrays from a straight line shape can produce significant distortions in beam patterns and errors in bearing estimation if the beamforming assumes linearity. A deformed array helps to remove left-right ambiguities in the beam patterns, provided the shape is known. These two effects are studied for undamped and damped sinusoidally deformed arrays with small deformation amplitudes. By use of fixed arc length separations along the array, the phone (x,y) coordinates are determined numerically. The error in assuming equal x spacing is shown. The complex pressure fields are modeled using BEAMSTATPAK of Collier. Then beamforming is carried out (1) with the known array configuration, and (2) assuming that the array is linear, and array responses are shown for each. Degradations resulting from assuming linearity and the ability to remove left-right ambiguities are discussed in terms of reduced gain, angular resolution, and bearing errors. Performance is reported as a function of deformation from 0.0 to 0.3. True peak-ambiguous peak signal gain differences range to 9 Db for sources at broadside and to just over 2.5 Db for arrivals near endfire. Shape unknown degradation ranges to 7 Db at broadside but is less than 1 Db near endfire.

Research Colleague at NORDA: D. Balzo

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(Ioup G, 1988)

DECONVOLUTION OF TRANSIENT SIGNALS FOR
CORRELATION PROCESSING AND MULTIPLE CORRELATION STUDIES

George E. Ioup

Department of Physics
University of New Orleans
New Orleans, Louisiana

Abstract

Correlation processing for distributed sensors is most accurate for short pulses and those whose autocorrelation is sharply spiked. For longer transient signals, multipath arrivals at each sensor have significant interference with each other, and it is difficult to identify individual arrival times. Deconvolution of the received signal to sharpen the transients is one method to decrease the overlap and increase the accuracy with which travel times can be identified. Deconvolution can also be applied after cross-correlation to sharpen the autocorrelation of the transients. Least squares deconvolution is the most commonly used approach for acoustic signals. It has the disadvantage of being computer intensive when filters for long transients are needed. An alternate approach, the single-filter application of the always-convergent iterative technique, is faster and provides variable control for noise. The two techniques are compared for actual underwater acoustic multipath transient signals. Single filter application of always-convergent iterative noise removal is compared to the use of a modified Blackman-Harris window for noise control. Both noise removal techniques are then applied simultaneously. This research is a collaboration with James H. Leclere and Robert L. Field of NORDA and Juliette W. Ioup of the University of New Orleans.

Research is also conducted with Juliette Ioup, Robert Field, and James Leclere into higher order correlations for arrival time and amplitude identification at multiple sensors. This investigation includes a variety of deterministic acoustic transient signals with phase, frequency, and amplitude modulation. The importance of the moments of the ordinate distributions and higher order spectra for predicting the success of multiple correlations is examined. Preliminary studies of the effects of multipath interference on correlation processing are also performed.

Abstracts on each topic have been submitted to the Acoustical Society of America for presentation at the fall 1988 meeting, and manuscripts are in preparation. A manuscript has been submitted for publication in the Journal of the Acoustical Society of America entitled "Performance Evaluation of Sinusoidally Deformed Line Arrays" with Deanna M. Caveny, Donald R. Del Balzo, and James H. Leclere.

Research Colleague at NORDA: R. Field

17

(Ioup G, 1989)

HIGHER ORDER CORRELATIONS AND SPECTRA FOR THE DETECTION OF DETERMINISTIC TRANSIENTS

George E. Ioup

Department of Physics
University of New Orleans
New Orleans, Louisiana

Abstract

The use of higher order correlations for the detection of essentially bandlimited, deterministic, finite energy signals is investigated. Three sample transients, a 20 Hz finback whale signal, a 0 Hz to 10 Hz version of the whale signal, and an amplitude modulated 5 Hz sinusoid, are used to illustrate the discussion. The study considers simple detectors, which detect on the peak value, as these provide basic information for the design of more sophisticated detectors. Signal properties such as moments and histograms of ordinate values, spectra, bispectra, and trispectra give considerable insight into higher order correlation detectors. These properties are discussed and applied to the sample signals. Finally, a performance analysis using hypothesis testing, Gaussian noise on the signals, and receiver operating characteristics (ROC) curves is done for the detectors and the results for limiting signal-to-noise ratios for good detection are presented in tabular form. The ordinary correlation performs well, as expected, and the tricorrelation performance is not much different. The bicorrelation detector does not do well for the whale signal because its bicorrelation central value and bispectrum are small. The bicorrelation is not a good simple detector for the low frequency whale because there is not a unique largest peak in its bicorrelation. Rectification of the signal as part of the detection process remedies both these drawbacks. This work has been performed with Lisa A. Pflug, Juliette W. Ioup, Kenneth H. Barnes, Robert L. Field, James H. Leclere, and Grayson H. Rayborn, and an abstract has been submitted for presentation to the Acoustical Society of America. A manuscript is in preparation.

The author also performed research and prepared a manuscript describing the results which has been submitted to the Journal of the Acoustical Society of America. The work is titled "Density-sound Velocity Relationships for Two Marine Surface Sediment Classes," and it was done with Grayson H. Rayborn and Juliette W. Ioup.

Research Colleagues at NORDA: R. Field and R. Slater

(Ioup J, 1987)

EFFECTS OF MEASURED MODE NONORTHOGONALITY ON CONVENTIONAL MATCHED FIELD PROCESSING

Juliette W. Ioup

Department of Physics
University of New Orleans
New Orleans, Louisiana

Abstract

The potential improvement achievable from the use of modal filtering in matched field processing is greatest when the measured modes are least orthogonal. The performance of matched field processing using a conventional estimator in the Pekeris model has been examined for ambiguity surfaces constructed using both the pressure fields at the phones and the amplitudes resulting after modal filtering. The quality of the surfaces is ranked using two measures: the height of the source peak above the mean value of the surface outside the peak divided by this mean or divided by the standard deviation of the background. The results indicate that modal filter processing, for a given array of hydrophones, offers the most improvement when bottom depth, bottom type, and frequency combine to produce measured modes that are the least orthogonal, and no improvement when the measured modes are orthogonal. The only region of consistent improvement is for depth and frequency combinations just above modal onset.

Research Colleague at NORDA: D. Balzo

EVALUATION OF HIGHER ORDER CORRELATION
PROCESSING OF AMPLITUDE- AND FREQUENCY-MODULATED
ACOUSTIC TRANSIENT SIGNALS AND DECONVOLUTION FOR
MULTIPATH ARRIVALS

Juliette W. Ioup

Department of Physics
University of New Orleans
New Orleans, Louisiana

Abstract

The triple cross correlation of three signals is a simultaneous function of two lags. It is an alternative to cross correlations taken two at a time for determining the lags for a given source at three distributed sensors. It should offer improvement in arrival time identification only when the statistics of the signal have significant third moment components. In this study, properties such as the moments and bispectra of amplitude- and frequency-modulated synthetic transient signals are investigated to find bases to predict the performance of the triple correlation. Initially autocorrelations of the signals are used as the ideal expected in a cross correlation approach. The third moment is related to the zero lag value of the autocorrelation. Nonzero domains of the bispectra can be very small for bandlimited signals, indicating limited usefulness for the triple correlation. Signals are also compared after propagation over several paths to three sensors for the effect of multipath on the triple correlation. Results are contrasted with the ordinary autocorrelations and cross correlations computed for the three signals taken two at a time. The efficacy of these two approaches is examined for a variety of amplitude- and frequency-modulated transient signals and multipath interference conditions. Preliminary investigations are also made into quadruple correlations for four sensors, including examination of the importance of fourth moments and trispecta. This research has been performed with George E. Ioup of the University of New Orleans and Robert L. Field and James H. Leclere of NORDA.

With James Leclere, Robert Field and George Ioup, research has been conducted on deconvolution of transient signals for correlation processing. Least squares and always-convergent iterative deconvolution techniques are compared. Iterative noise removal and a modified Blackman-Harris window are employed for noise control.

Abstracts on each topic have been submitted to the Acoustical Society of America for presentation at the fall 1988 meeting, and manuscripts are in preparation.

Research Colleague at NORDA: R. Field

DENSITY-SOUND VELOCITY RELATIONSHIPS FOR
TWO MARINE SURFACE SEDIMENT CLASSES

Juliette W. Ioup

Department of Physics
University of New Orleans
New Orleans, Louisiana

Abstract

The density to reciprocal sound velocity dependence of two predominant classes of continental shelf surface sediments as measured by Hamilton (1980) can be described as a subclass of Nobes's cases (1989) by the Wood equation (1941) or by straight line fits to the Wood equation or the data (1986). The data classes can be characterized as sand-silt and clay-sand-silt. Although the Wood equation is nonlinear in density versus reciprocal sound velocity, for the porosity domain of these sediments it is nearly linear, as are the measured data. Also a linear relation may be derived from the Wood equation by doing a Taylor's series expansion about the midpoint velocity-density value for each sediment type. These results can be used to choose model study parameters, to calculate sediment densities from shipboard measured sound speeds, or to estimate average grain densities and velocities from measured bulk sediment densities and sound speeds. This work has been performed with Dr. George E. Ioup and Dr. Grayson H. Rayborn. A manuscript describing the results has been submitted to the Journal of the Acoustical Society of America.

The author has also worked with George E. Ioup, Lisa A. Pflug, Kenneth H. Barnes, Robert L. Field, James H. Leclere, and Grayson H. Rayborn on a study of higher order correlations and spectra for the detection of deterministic transients. An abstract has been submitted for presentation to the Acoustical Society of America. A manuscript is in preparation.

Research Colleagues at NORDA: R. Slater and R. Field

BACKSCATTERING STRENGTHS, REVERBERATION MODELLING, AND NORMAL MODE APPROXIMATIONS IN UNDERWATER ACOUSTICS

Juliette W. Ioup

Department of Physics
University of New Orleans
New Orleans, Louisiana

Abstract

Analysis of data from the 1989 Blake-Bahama Basin Deep Towed Acoustics-Geophysics System (DTAGS) experiment has yielded normal incidence backscattering strengths for the sea bottom. Interesting features were found over the escarpment. The horizontal DTAGS streamer of 24 receiver groups permitted relative scattering strengths to be obtained as a function of grazing angle. The DTAGS chirp source covers a range of frequencies from 250 to 550 Hz, and relative scattering strengths were also presented as a function of frequency. (With Mary Rowe, Joe Gettrust, and Richard R. Slater of NOARL, George Ioup of UNO, and Grayson Rayborn of USM.)

A ray tracing algorithm was used to model the bottom reverberation for a Pekeris waveguide with a variety of marine bottoms including sands, silts, and clays. Monostatic and quasi-monostatic cases were studied. Effects of attenuation in the bottom were also considered. In addition to the horizontal case, sloping bottoms between three and fifteen degrees were investigated. Results from the model were used to draw conclusions about the magnitude and importance of these and related parameters in calculations of bottom reverberation. (With Richard R. Slater of NOARL, Grayson Rayborn of USM, and George Ioup of UNO.)

Previous investigators have recognized that an approximation may be made to the eigenfunctions and eigenvalues for a Pekeris waveguide such that the eigenfunctions end in a node at an effective pressure release bottom below the actual bottom. We obtained a simple graphical derivation of the approximation and investigated the accuracy of the approximation for the marine sediments found to be typical of bottoms along the Continental Shelf. For a water column capable of supporting up to 74 modes, the approximation resulted in errors in the vertical wavenumber of less than 0.25% for all modes for all bottom types. This modest error indicates that the approximation should be useful in modelling various problems. (With Richard R. Slater, James K. Fulford, and Jim Showalter of NOARL, Barry Barker and Grayson Rayborn of USM, and George Ioup of UNO.)

Research Colleague at NOARL: R. Slater, Jr.

(Jacobus, 1987)

ACCELERATED SULFIDE INDUCED CORROSION

O. John Jacobus

Department of Chemistry
Tulane University
New Orleans, Louisiana

Abstract

The problem of sulfide induced accelerated corrosion of 90:10 copper-nickel piping systems constructed in polluted estuarine waters has been recognized for ca. 15 years. The purpose of the current research undertaken was two fold: (1) to determine the cause of such selective corrosion as has been previously observed and (2) to test methods designed to alleviate the corrosion problem.

Initial studies dealt with the weld and adjacent heat affected zone of 70:30 copper-nickel welded 90:10 copper-nickel pipe. Metallic segregation was detected in both the weld root and the heat affected zone; the weld and immediately adjacent zone are coated with a thick, highly adherent layer of essentially pure cuprous oxide (EDAX) while the adjacent heat affected zones are markedly nickel enriched relative to parent plate. Similar observations relative to the heat affected zone were made on pipe samples which were sleeve welded or externally bead welded to simulate sleeve welds. The copper enriched areas are susceptible to sulfide derivatization while the adjacent nickel enriched areas do not appear to suffer such attack. The sulfide coated copper enriched areas are cathodic relative to adjacent uncoated (Ni enriched) areas; selective corrosion under oxidative conditions occurs in the nickel enriched areas.

Preliminary studies on ferrous (Fe+2) ion and sulfite (SO3-2) ion corrosion inhibition were undertaken; the former treatment appears ineffective while the latter appears promising in alleviating sulfide induced accelerated corrosion.

Research Colleagues at NORDA: B. Little and P. Wagner

(Jin, 1990)

STOCHASTIC INVERSION OF GEOMAGNETIC DATA

Rong-Sheng Jin

Department of Physics and Space Sciences
Florida Institute of Technology
Melbourne, Florida

Abstract

An investigation into the application of stochastic inversion to multi-year geomagnetic data analysis was initiated. A computer program with two subroutines of prototype were developed to estimate the Gauss-Schmidt coefficients for multi-years. The program does require the use of the IMSL math subroutines. Further work is needed to verify the operations of the program for different operating conditions and on its interface with the actual data. The problem of the inversion of a large matrix (10,000 rows by 10,000 columns) associated with a large amount of magnetic data and the Gauss-Schmidt coefficients for multi-years remains to be considered. A supercomputer is preferable for the stochastic inversion rather than the VAX-11. In that case, the current IMSL math subroutines coded for the VAX-11 must be replaced by other suitable math subroutines. The program developed together with its subroutines should be useful in NOARL's continuing efforts to form a predictive model of the earth's magnetic field.

Research Colleague at NOARL: M. McLeod

(Jin, 1991)

MULTI-YEAR STOCHASTIC INVERSION OF MAGNETIC
OBSERVATORY ANNUAL MEANS

Rong-Sheng Jin

Department of Physics and Space Sciences
Florida Institute of Technology
Melbourne, Florida

Abstract

A computer program INVERT.F was developed to do spherical harmonic analysis of multi-year magnetic observatory annual mean data. The method of stochastic inversion is used to obtain the secular variations of the Gauss-Schmidt coefficients of the magnetic potential function. This is part of the Global Geomagnetics Project to improve geomagnetic prediction modeling techniques.

The program INVERT.F was written to be used on the supercomputer CRAY Y-MP. INVERT.F contains two subroutines, SELECT and WCAL. The subroutine SELECT will select the magnetic data for a given internal of years from the magnetic observatory annual means, and the subroutine WCAL will calculate the necessary elements of the matrices containing the information on the positions of the magnetic observatories. The SELECT and WCAL outputs are used in the main INVERT.F program with the mathematical software LINPAC on CRAY Y-MP to perform matrices inversions of very large dimensions.

The program INVERT.F has been used to obtain the dipole moments of the earth for the period from 1900 to 1984 using simple a priori information on the Gauss-Schmidt coefficients and data errors as a test case. More investigations and developments are needed on the a priori covariance matrix of the magnetic data errors and the covariance matrix of the Gauss-Schmidt coefficients so that their time dependence is taken into account. The program INVERT.F together with the appropriate covariant matrices can be used to improve the geomagnetic prediction model at NOARL.

Research Colleague at NOARL: M. McLeod

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(Kozo, 1988)

THE ORIENTATION OF WIND-GENERATED POLYNYI
ALONG THE SOUTH COASTS OF EASTERN BERING SEA ISLANDS

Thomas L. Kozo

Department of Oceanography
U.S. Naval Academy
Annapolis, Maryland

Abstract

An initial study has been launched to investigate the relationship of winds derived from mesoscale meteorological networks (Kozo, et al, 1987) to polynya creation thresholds. The major emphasis is on all-weather nowcasting of polynya areas and orientations. Visible-band satellite imagery (NOAA-AVHRR) was merged with atmospheric pressure network data (National Meteorological Center; NMC) from the Bering Sea for March 1988.

During the month, there was a tendency for storms to propagate zonally across the southern Bering or northward across the Alaskan side of the Bering Sea. Both situations result in driving sea ice southward (Pease, et al, 1982) and the creation and maintenance of polynyi off the south coasts of St. Lawrence, St. Matthew, and Nunivak Islands (Cavalierei et al, 1983). The recent deployment of a moored pressure buoy south of the ice edge in the open ocean and an automated weather station on St. Matthew Island has allowed the "creation" of lee shore polynya mesonets in conjunction with existing land stations in the eastern Bering Sea area. Mesoscale geostrophic winds were computed from these network data. In each case, the networks were chosen because they surrounded polynyi loci.

Use of this higher resolution mesoscale analysis (rather than synoptic) has shown that the polyna orientations for each of the three study islands can be simply related to the mesonet computed geostrophic winds. The synoptic analysis from NMC is not sufficient to predict orientations since it cannot produce precise wind stress directions at each of the three islands and normally does not show the detail necessary for stress prediction on moderate wind days. The time lag between the appearance of a pressure related geostrophic wind and the "windsock" type tracking of the lee shore polynyi is on the order of 48 hours.

Research Colleagues at NORDA: L. Farmer and .. Welsh

BERING SEA ISLAND LEE SHORE POLYNYI CHARACTERISTICS
PREDICTED BY MESONET GEOSTROPHIC WINDS AND CLOUD LINES

Thomas L. Kozo

Oceanography Department
U.S. Naval Academy
Annapolis, Maryland

Abstract

Wind velocities derived from mesoscale meteorological networks and wind directions derived from cloud lines have been related to polynya sizes and/or orientations. Visible-band satellite imagery from the Defense Meteorological Satellite Program and NOAA-AVHRR was merged with atmospheric pressure network data (National Meteorological Center, NMC) from the Bering Sea for March and April 1988.

During both months there was a tendency for storms to propagate zonally across the southern Bering or northward across its Alaskan side. This storm path tendency creates persistent polynyi off the southern coasts of St. Lawrence, St. Matthew and Nunivak Islands. These latent heat polynyi (Smith,1988) apparently are subject to a combination of wind speed, air temperature, and increasing solar radiation (Spring) that prevents their maturation within a typical synoptic period of 5 days. The survival of a new moored pressure buoy in open water south of the ice edge and a new automated weather station on St. Matthew Island has allowed the "creation" of unique atmospheric pressure networks. These above data stations, when coupled to existing land stations in the eastern Bering Sea have convenient polynya-surrounding geometry. Mesoscale geostrophic winds can be computed from the network data for each study polynya.

Cloud lines on the satellite imagery are clues to surface wind directions in the Bering. These lines are rows of cumulus clouds formed by cold air advection over relatively warmer water. If the lines remain parallel over long distances, they indicate almost constant wind directions at low levels.

The mesonet analyses (rather than synoptic) have shown that the polynya size and orientations for each of the study islands can be simply related to the mesonet computed geostrophic winds in March and April 1988. The cloud lines from the satellite imagery are consistent with the mesonet-derived wind directions as well as the polynya orientation. The typical time lag between the onset of geostrophic wind forcing and "wind sock" type tracking of the lee shore polynyi shape is 24 hours.

(Leben, 1990)

EOF ANALYSIS FOR ALTIMETER DATA ASSIMILATION STUDIES
IN THE GULF OF MEXICO

Robert R. Leben

Department of Aerospace Engineering Sciences
University of Colorado
Boulder, Colorado

Abstract

Data sets have been produced on a regular space-time grid using altimeter data from GEOSAT, collected during the three-year exact Exact Repeat Mission (ERM). They are based on empirical orthogonal eigenfunction (EOF) expansions determined using the Naval Oceanographic and Atmospheric Research Laboratory (NOARL) Gulf of Mexico primative equation model.

EOF expansions using a 5-year data subset of a 20-year model simulation produced regression coefficients for the deep pressure field using only the upper layer pressure anomaly. This will allow reconstruction of the deep pressure from sea surface height anomalies determined from satellite altimeter data alone. The EOF expansions are able to reconstruct the deep pressure field with remarkable accuracy. Reconstruction using either the 5-year dependent regression data set or an independent 5-year data set from the simulation yielded correlation coefficients of 0.98, computer relative to the true model lower layer fields.

EOF analysis was further used to produce regularized data sets of the upper layer pressure from the altimeter data. Once a regularized data set is produced, the lower layer pressure is determined using the previous analysis. Work is in progress to determine the eigenmodes and Fourier frequencies necessary to represent the variance of the three-year GEOSAT altimetry time series. Model initialization, assimilation, and verification experiments will be performed for the Gulf of Mexico once an optimum upper layer pressure data set has been determined and the corresponding lower layer pressure statistically estimated.

Research Colleagues at NOARL: D. Thompson and D. Fox

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(Lewis, 1988)

MODELS FOR SOLAR AND SHORTWAVE SKY RADIATION
INPUT TO OCEAN OPTICS MODELS

Lonzy J. Lewis

Department of Physics and Atmospheric Sciences
Jackson State University
Jackson, Mississippi

Abstract

A convenient method for generating direct spectral solar irradiance and short wave spectral sky radiance for input to ocean optics models was sought. Important features of the model must include absorption and scattering by the main atmospheric components: Rayleigh atmosphere, ozone, aerosols, water vapor, and clouds. Output was sought under all sky conditions ranging from clear to overcast. Other considerations of the model include ease and economy of use.

A literature search was conducted revealing many possible models ranging from very sophisticated, all encompassing models to simple models which require a minimum of input. Two simple spectral models that treat the atmosphere as one layer and are capable of running on microcomputers were chosen. These models however are restricted to clear sky conditions. Output from the models include direct beam irradiance, diffuse horizontal irradiance, and total or global horizontal irradiance for any wavelength band between 0.3 micrometers and 4.0 micrometers. Atmospheric inputs are precipitable water amount, aerosol optical depth and ozone concentration. Two methods were used to generate a sky radiance distribution. One method used an empirical function based on measured data. The other used a scattering function for the atmosphere composed of a Rayleigh component and a Mie or aerosol component. A Henyey-Greenstein phase function was used to generate the Mie scattering function.

The sky radiance distribution function was used in conjunction with the total diffuse irradiance derived from the irradiance model to generate the sky radiance value. An empirical function was also determined for overcast skies based on measured data. Both thin and thick overcast conditions were included in the data but no means exists for classifying the type of overcast in the empirical relationship. Hence, the distribution function is an average for all overcast conditions.

No suitable model was found for partly cloudy conditions.

Research Colleague at NORDA: R. Hollman

(Leybourne, 1987)

SOFTWARE DEVELOPMENT FOR DETERMINATION
OF SINGLE CHANNEL ARCTIC NOISE DATA

Allen E. Leybourne, III

Department of Engineering Technology
University of Southern Mississippi
Hattiesburg, Mississippi

Abstract

Software was developed for use on a VAX 780 in Fortran 77 for the purpose of determination of statistical characteristics of arctic single channel noise data; mean, standard deviation, skew and kurtosis and other information is calculated. Although the technical task is relatively straight forward, because of specific organization of the source data files, the file processing task was somewhat unusual. Many processing options were built in, e.g., the data series can be split into contiguous, segmented or overlapped groups, either by number of points or time period of the data series. The data series is checked for data gaps with controls to reject data groups in non-conformity with user specification. One option developed was the conversion of the original file to a residual file (difference from a controllable number of point running average) in format suitable for processing by the main programs.

Output files are prepared for plotting in a number of special formats; cumulative sum, histogram, or Chi square selected ranges. The Chi square statistic is reported for the distributions; Normal, Maxwell, Rayleigh, Riceian, Weibull, and Gamma.

Processing of arctic data was limited to a single file, supplied to the author for program development purposes. During development of the software it was observed that a Weibull distribution, with origin located at zero obtained the best fit to this data. Obviously, no general conclusion can be drawn from this limited observation. It can be noted that both the Rayleigh and Riceian distributions can be represented by the more general distribution, Weibull.

Research Colleagues at NORDA: C. Mire, M. Lawrence, and D. Ramsdale

DETERMINATION OF A MEAN SQUARED COHERENCE ANALOG FOR TRANSIENTS USING MODELED UNDERWATER EXPLOSIVE DATA

Allen E. Leybourne, III

Department of Engineering Technology
University of Southern Mississippi
Hattiesburg, Mississippi

Abstract

Conceptually, two transient signals of short duration can be considered to be coherent or non-coherent just as is the case for relatively stationary ones. The frequency dependent, mean square coherence estimator, MSC, is often used to differentiate these extremes, by obtaining repeated estimates of the signal spectra for independent realizations of the signal. When the Discrete Fourier Transform (or other methods) are used to obtain these spectral estimates, an insufficient number of independent estimates is obtained to determine a stable and relatively unbiased value of the frequency dependent MSC. Utilizing existing experimental data sources for underwater explosive shot data, a model of the shot transient signal was developed which included the parameters; range, charge weight and depth. Vertical bubble migration was not included, however. Controlled amounts of Gaussian noise was added, while various means of calculating an MSC analog were examined.

Ordinarily, linear changes, e.g. a simple time delay, will not of themselves affect the value of MSC for stationary signals. This study has shown that time alignment of transient signals (of course easily done during model simulations) is extremely critical, perhaps outweighing almost any other consideration. Frequency domain averaging has been used and found to produce very believable MSC estimates for the specific transients simulated. The method is referred to as an MSC analog, as the value calculated has many of the properties of the conventional statistic, including a systematic bias, dependent upon the number of spectral values used in the estimate. The method produces a frequency dependent, MSC averaged over several frequencies. Results obtained by the method are not as statistically stable as the conventional MSC estimator. However, it is believed the method, when used under well known, and controlled conditions, can accurately describe, at least, the relative level of coherence between separate similar transient processes.

Research Colleagues at NORDA: D. Ramsdale and R. Meredith

(Leybourne, 1989)

ISOLATION OF ARCTIC UNDERWATER NOISE EVENTS

Allen E. Leybourne, III

Department of Engineering Technology
University of Southern Mississippi
Hattiesburg, Mississippi

Abstract

A significant collection of under-ice ambient noise has been recorded during previous arctic field studies. Typically multi-channel VCR tape recording systems have been used as the initial recording method. Using a streaming mode technique, these VCR tapes are digitized and transferred to 9" magnetic tapes. The data is voluminous, e.g., digitizing 1 hour of 8 channel VCR tape at 2500 Hz nearly fills a conventional 9" 6250 bpi digital tape.

Even though the ambient noise is the summation of many noise sources, high level noise periods appear to be characterized by essentially transient discrete noise events or combinations of relatively small numbers of such events. Thus it is possible to isolate many interesting noise events. Significant data reduction is possible if the intervening background noise periods are deleted. Most of the original structure of the ambient noise is retained if the time index of the higher level events is maintained.

This study was initiated to develop techniques and software which can pre-process the ambient noise tapes to take advantage of the data reduction possibilities and reduce software complexity during subsequent processing and analysis. Techniques and companion software have been developed for isolation of events at prescribed levels above the background. The individual noise events are transferred to disk files, numbered (catalogued for quick access) and graphically rendered to hardcopy to facilitate visualization.

The streaming mode tape files which are in an interleaved, difficult to read format, are reformatted simplifying subsequent processing. Using a list of the specific events chosen for study permits direct access without need for scanning the origin source tapes. Thus software for statistical analysis of features of the noise transients such as: magnitude, duration, and frequency of occurrence and approximate range to the source (from time delay information between channels) is significantly less complex.

(Martinez, 1987)

ADAPTIVE ESTIMATION OF OCEAN DEPTH USING MULTISPECTRAL SCANNER DATA

Andrew B. Martinez

Electrical Engineering Department
Tulane University
New Orleans, Louisiana

Abstract

The estimation of ocean depth using passive illumination measured by multispectral scanner (MSS) was investigated. Most previous work has been based on a simple model relating illumination to bottom reflectance, water condition, and bottom depth. Numerous techniques have been developed to invert the model equation. Unfortunately, this usually proves to be computationally expensive, requiring linearization, multilinear regression, or estimating the bottom reflectance and water condition. As an alternative to these model based approaches, a linear estimator and an adaptive procedure, the LMS algorithm, was considered to dynamically update the estimator weights as the survey proceeds. The adaptive algorithm requires two inputs to adapt the weights, the MSS data and an independent estimate of the true depth at the same point. For the MSS being developed at NORDA, the independent depth estimate is available from an on-board laser sounder. Once the locally optimal weights are found, they can be used to estimate depth from MSS data at points where there are no laser soundings. The algorithm was tested and found to perform well on data from a 1980 survey of the Bahamas.

Research Colleague at NORDA: R. Joy

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CURVE FITTING USING GENETIC ALGORITHMS WITH APPLICATIONS TO AN ALTIMETER DERIVED REFERENCE SURFACE ERROR

Kenneth C. Messa

Department of Mathematical Sciences
Loyola University
New Orleans, Louisiana

Abstract

Genetic algorithms are search techniques based on the mechanics of natural selection. They have been used successfully in many applications because of their robustness and because of their ability to search in a noisy problem space. In particular, genetic algorithms are used in curve-fitting. The genetic algorithm selects the coefficients of a particular curve that most closely matches a given set of data.

Candidate solutions are vectors of real numbers that represent the coefficients of the curve to be modeled. Thus, every candidate solution corresponds to a new function. As such, each candidate solution is evaluated using the sum of the squares of the residuals. The evaluation of each of these curves with respect to its fit of the data guides the genetic algorithm toward the solution with the greatest merit.

An application of this technique involves the calculation of the "synthetic geoid." One analytic technique models an altimeter sea surface height residual profile as an instantaneous front minus a mean front. As these fronts have hyperbolic tangent shape, a mathematical model of the sea surface height is given by $SSH(X) = A*\tanh(B*(x - D - E)) - F*\tanh(C*(X - E)) + G$. By fitting this curve to the altimeter data, one can produce an improved profile of the front.

(Messa, 1991)

GENETIC ALGORITHM APPLICATIONS TO REMOTE SENSING OCEANOGRAPHY

Kenneth C. Messa

Department of Mathematical Sciences
Loyola University
New Orleans, Louisiana

Abstract

Genetic algorithms are optimization techniques that are based on the mechanics of natural selection and evolution. They have been used successfully in many different applications because of their flexibility and because of their ability to search in a noisy environment. Genetic algorithms are used to explore three applications of remote sensing oceanography -- geoid correction using altimeter residuals, automated generation of pattern recognition systems and generalized least-squares curve fitting.

Geoid correction using altimeter residuals -- one technique for calculating the "synthetic geoid" models are altimetric sea surface height residual profile as an instantaneous front minus a mean front. By fitting this model to altimeter data using genetic algorithms, one can improve the profile of the front.

Automated generation of pattern recognition systems -- Ocean mesoscale feature detection is the goal of a pattern recognition system. The system uses genetic algorithms to identify a detector set that best labels a prototype set of images. A Hamming neural network is used to develop a more selective prototype set.

Generalized least-squares curve fitting -- Least-squares techniques of fitting curve to data (such as the geoid correction technique above), usually involve the erroneous assumption that there is no error in the independent variable(s)measurements. In fact, errors are found in all measurements. Genetic algorithms are used to fit curves to data where there are no assumptions made about the errors in the measurements of the independent variables.

Research Colleague at NOARL: M. Lybanon

(Miller, 1990)

DEVELOPING AN ALGORITHM TO DISCRIMINATE AMONG CLOUD, SNOW, AND LAND PIXELS IN NOAA-AVHRR DATA

A. Woodruff Miller

Civil Engineering Department
Brigham Young University
Provo, Utah

Abstract

An algorithm has been developed to discriminate among cloud, snow, and land pixels in AVHRR data. The NOAA-AVHRR system provides four bands of data. Bands 1 and 2 are near-infrared, Band 3 is mid-infrared, and Band 4 is thermal infrared. Snow and clouds display high near-infrared reflectivity (albedo) while vegetated land displays low albedo. This difference in Band 1 values is used to classify the vegetated land pixels. However, sand and salt covered area displays high albedo like snow, so these pixels are classified as land based on their high temperature from the Band 4 data. Since the mid-infrared data of Band 3 contains both reflected and emitted (thermal) radiation, a synthetic band, which displays the reflective radiation of Band 3, can be generated by subtracting Band 4 from Band 3. Clouds generally have much lower temperatures (Band 4) than snow, so the Band 3 minus Band 4 values are higher for clouds than for snow. This difference in the synthetic band is used to classify the cloud pixels. With the land and cloud areas identified, the remaining pixels are classified as snow.

For the land versus cloud classification, a maximum Band 1 (albedo) threshold is required. For the land versus snow classification, the minimum Band 3 minus Band 4 (difference) threshold is a positive slope line with zero intercept. The cloud classification requires two minimum Band 3 minus Band 4 thresholds, one for low (land) albedos and one for high (snow) albedos. Finally the sand versus snow threshold. Most of the present effort has been to establish these thresholds which are season and satellite overpass time dependent. Several AVHRR scenes have been studied and threshold values have been determined. The algorithm is considered to be an effective classifier for clouds, snow, and land when appropriate thresholds are used. The algorithm is now included in the general cloud classification program at Naval Oceanographic and Atmospheric Research Laboratory, Atmospheric Directorate, and can be used to identify snow below the clouds.

Research Colleagues at NOARL: K. Richardson, C. Crosiar, T. Tsui, and
E. Barker

(Murphy, 1987)

A FINITE ELEMENT MODEL FOR OCEAN ACOUSTIC PROPAGATION

Joseph E. Murphy

Department of Physics
University of New Orleans
New Orleans, Louisiana

Abstract

Work continued on the development of a finite element computer model for ocean acoustic propagation. The model describes acoustic propagation in range-dependent environments, and gives a numerical full-wave solution, i.e., includes backscatter. Approximate expressions for several integrals needed to evaluate the contributions of individual elements to the full system of equations were replaced with exact expressions, and a more accurate treatment of radiation boundary conditions was added to the computer model. An earlier Gaussian direct elimination solution technique for the complex, banded, symmetric system has been replaced with a banded symmetric factorization of the system. Very favorable comparisons have been made with PE and Evans' Coupled Mode Model in the case of a range-dependent (upslope wedge) problem. Because of its flexibility, the finite element model is believed to be the best starting point for the development of a full-wave model including shear effects in the ocean bottom.

Research Colleague at NORDA: S. Chin-Bing

(Philpot, 1988)

BATHYMETRIC MAPPING WITH PASSIVE, MULTISPECTRAL IMAGERY

William D. Philpot

Civil and Environmental Engineering
Cornell University
Ithaca, New York

Abstract

The feasibility of mapping bathymetry from satellite or aircraft imagery has been demonstrated by several researchers, with techniques ranging from photointerpretation and photogrammetry to computer analysis of multispectal satellite imagery. Multispectral methods have proven reasonable successful when water quality, bottom reflectance and atmospheric effects are all invariant over the scene. Under these conditions it may even be possible to discriminate among bottom types. Alternatively, when the bottom reflectance is constant, it may be possible to discriminate between two distinctly different water types and to estimate relative values of the spectral attenuation and water reflectance. However, neither reflectance nor attenuation of shallow coastal waters has been determined absolutely from passive remote data and, where the water quality is variable, even attempts at extracting consistent depth information have been less than successful.

This study addressed the use of multispectral imagery for quantitative bathymetric mapping and explored some of the problems which must be dealt with when attempting to extract depth information under less than ideal conditions, e.g., variable bottom reflectance and water type. When only the depth and bottom type vary within a scene, the depth, bottom contrast and effective spectral attenuation can be extracted from the multispectral data. However, when the water type or atmospheric characteristics vary over the scene, results using only spectral information can be ambiguous. Strictly spectral information is inadequate in general for extracting information about depth and water quality. Some external source of information is required. Extensive point samples of depth can be used, but where such is not available, spatial information in the image can probably be used to reduce the ambiguity at a minimum.

Research Colleagues at NORDA: S. Haimbach, L. Estep, C. Walker, and L. Hsu

(Puri, 1989)

NUMERICAL SIMULATION OF ALGERIAN CURRENT

Kewal K. Puri

Department of Mathematics
University of Maine
Orono, Maine

Abstract

A numerical study was undertaken to simulate the Algerian current and to study its energetics. The current flows along the Mediterranean Coast near 0 degrees and becomes unstable near 1 - 2 degrees East. The project is to be accomplished by using Harvard Open Ocean Model. The latter, a quasi-geostrophic model, entails solving a pair of coupled partial differential equations in relative vorticity and a stream function, in a finite domain in the ocean. These equations are to be solved subject to open boundary conditions in which the stream function is specified at all boundaries and the vorticity at the inflow points. The vertical resolution is provided by a dynamical mode expansion based on an auxiliary eigenvalue problem that also uncouples the differential equations. The horizontal accuracy is obtained by using a fourth order accurate finite element method.

Research Colleague at NORDA: K. Saunders

BOTTOM SCATTERING AND ACOUSTIC PROPAGATION

Robert D. Purrington

Department of Physics
Tulane University
New Orleans, Louisiana

Abstract

A study was undertaken of the effects of bottom roughness on the propagation of sound in the ocean. The propagation was modeled using a finite element energy conserving parabolic equation (PE) code due to Collins and Westwood (1989). The primary purpose of the study was to investigate the effect of superimposing a stochastic roughness component upon the known deterministic bathymetry. The results of up to 100 scatterings from individual randomly generated surfaces with appropriate roughness parameters were ensemble-averaged to reduce the effects of statistical fluctuations. Surfaces with Gaussian roughness spectra and with a K^{-5} power law spectrum with a roll-off at the origin were employed. Studies of the effects of variation of the roughness parameters of the surfaces indicated that the energy scattered incoherently (non-specularly) by the PE model increased dramatically with an increase in rms roughness, as expected. At large values of the roughness, essentially all energy was incoherently scattered. The structure of the scattered field was examined in both the spatial and wave-number domains.

The question of the best strategy for incorporating roughness into a propagation model, given constraints imposed by computing resources, especially in a broad-band calculation, was addressed by considering the possibility of abandoning the "full-physics" approach and parameterizing the results of Monte-Carlo calculations done on finite 1-D rough surfaces. Angular distributions of scattered energy were obtained from ensemble-averaged scatterings from finite rough surfaces carried out by numerically integrating the Helmholtz equation for the complex pressure field at the surface. It was found that the best way to parameterize these results was to modify the closed form angular distribution which results from a small-perturbation calculation. The larger issue, of applying the resulting specular reflection coefficient and angle-dependent scattering strength at the water-sediment interface (or basement, etc.) remains unresolved, although there are promising approaches to finding the field at the bottom in k-space which are due to Norton and Kieffer (1991) and to McCoy (1991).

Research Colleagues at NOARL: S. Chin-Bing, G. Norton, and R. Kieffer

(Rayborn, 1987)

NONORTHOGONALITY OF MEASURED NORMAL MODES OCCASIONED BY SPAN AND DENSITY OF VERTICAL HYDROPHONE ARRAYS

Grayson H. Rayborn, Jr.

Department of Physics and Astronomy
University of Southern Mississippi
Hattiesburg, Mississippi

Abstract

Nonorthogonality of measured normal modes interferes with extraction of normal mode compositions. That considerable nonorthogonality existed in normal modes even when they are measured by dense arrays that span the entire water column has been previously established. These results are extended to sparse arrays, to dense arrays that span only part of the water column, and to sparse arrays that span part of the water column, for a variety of sediment types. Partial span arrays, both dense and sparse, are found to produce measured normal modes that are highly nonorthogonal. Contravening expectations, however, sparse arrays that span the entire column are found in every case studied to produce less nonorthogonality than the dense arrays as long as the array contains more phones than the number of trapped normal modes present. In particular, the full-water-column-span sparse arrays are found to produce a zone of orthogonality for a small range of frequencies and water column depths in which the measured nonorthogonality almost vanishes. The regions of orthogonality, which are found for all bottom types studied, occur just before the onset of the trapped mode whose mode number is equal to the number of phones in the array.

Research Colleague at NORDA: D. Del Balzo

(Rezak, 1987)

EFFECTS OF CONSOLIDATION ON MICROFABRICS OF CARBONATE SEDIMENTS

Richard Rezak

Department of Oceanography
Texas A&M University
College Station, Texas

Abstract

It is a well-known fact that the consolidation curves of carbonate sediments are quite different from those of clayey sediments. Determining the effects of consolidation on the microfabrics of natural carbonate sediments was the major goal of this research project. Microfabrics are defined as (1) grain-to-grain relationships (shapes, orientations, nature of grain to grain contracts), (2) grain to matrix relationships (grain supported vs. matrix supported sediment), and matrix component particle relationships (shapes, sizes, orientations, nature of particle-to-particle contacts). Other features noted include lamination, nature of void spaces, crushing of grains and matrix particles, presence or absence of cement, and nature of cements, if present. Grains are particles greater than 20 micrometers in diameter, and matrix is considered to consist of particles less than 20 micrometers in diameter.

Thirty-two samples were taken from 11 cores collected from Little Bahama Bank and Exuma Sound in March 1987. Sampling intervals were based on radiographs of the cores and were taken in areas of uniform lithology. Samples were taken immediately above consolidometer samples for pre-consolidation studies and from the center of the consolidation sample for post-consolidation studies. Two sets of samples were taken. One set was prepared for scanning electron microscopy (SEM) and the other prepared for thin-sectioning for the light microscope.

Two Whykham-Farance consolidation frames with fixed ring consolidometers were used. As the length of time for a consolidation test is approximately one month, only four samples were consolidated during the period from mid-June to mid-August. During the waiting periods for the post-consolidation samples, the bulk mineralogy of the 32 samples was determined by use of x-ray diffraction and techniques were developed for the preparation of samples for SEM and light microscopy. Time permitted the preparation of only 4 sets of samples from the Little Bahama Bank (Cores, 10H, 10P, 15H, and 16P). Two samples from each core were examined using SEM, one pre-consolidation and one post-consolidation. No crushing of grains was noted, probably because of the cushioning effect of the matrix. However, there were subtle differences in the packing of the matrix particles. The post-consolidation samples appeared to be a more tightly packed mass of aragonite "jackstraws" than the pre-consolidation samples with some apparent crushing of the matrix particles. The results, although preliminary at this point, are very promising and warrant a continued effort in this research.

Research Colleagues at NORDA: P. Valent and Dawn Lavoie

MICROFABRICS OF CARBONATE SEDIMENTS

Richard Rezak

Department of Oceanography
Texas A&M University
College Station, Texas

Abstract

This study seeks to understand the relationship between microfabrics and the geotechnical properties of carbonate sediments. In addition to the study of particle to particle relationships in the sediment, emphasis has also been placed upon the porometry of the sediment, i.e. the sizes and shapes of pore spaces as determined by particle to particle relationships. Carbonate samples from Little Bahama Bank and Exuma Sound were examined and photographed before and after consolidation to 4.32×10^3 kPa. using an AMRAY Model 1000A Scanning Electron Microscope (SEM). Quantitative pore size analysis was done on the AMRAY utilizing a Lemont Scientific Model DA-10 Image Analyzer. Light microscopy was utilized to verify the skeletal components not recognizable under the SEM. A Leitz Orthoplan Petrographic Microscope was used for examination of thin sections prepared from plastic impregnated sediment and a Leitz Binocular Stereo-Microscope was used to examine scatter mounts of sediment in reflected light under low magnification. Porosity, permeability, and grain size distribution were also determined for each sample. The results of the study support the premise that microfabrics and grain size distribution play significant roles in determining the physical properties including porosity and permeability of recent uncemented carbonate sediments. The use of computer processing of SEM images appears promising, particularly in the study of pore size reduction due to consolidation and/or cementation. The technique may well develop into a powerful tool for quantifying pore reduction by these two processes for the purpose of recognizing diagenetic stages in the history of a carbonate sediment. Such a tool would not only be useful for interpreting the bearing capacity of a carbonate soil for foundation purposes but also as an exploratory tool in the search for hydrocarbon resources.

Research Colleagues at NORDA: P. Valent and Dawn Lavoie

(Russo, 1987)

ANALYSIS OF AIRCRAFT AND OCEAN PLATFORMS
FOR SUPPORT OF MAGNETIC EQUIPMENT

Edwin P. Russo

Mechanical Engineering Department
University of New Orleans
New Orleans, Louisiana

Abstract

A finite element analysis using the NASTRAN computer program was initiated. The purpose of the analysis was to determine the stresses that would develop on the magnetic equipment support structure located in a P-3 aircraft in the event of a crash. The support structure was an aluminum box beam rigidly attached to the interior of the aircraft near the rear of the airplane. An adequate structural attachment between the magnetic recording equipment and the box beam had to be designed in order to withstand the aforementioned crash impact landing. A preliminary model has been developed by personnel at the Naval Air Test Center, Patuxent River, Maryland. The final model will include weight, center of gravity, etc. information when these data become available from the vendor. This investigator has the responsibility for verifying the computer model and analyzing the program output for accuracy and completeness.

An investigation and analysis of various ocean-going vessels for mounting geomagnetic recording instruments was conducted. Requirements of non-magnetic and preferably non-metallic, as well as stability in an ocean environment, may make the design and deployment of such a platform very expensive. Personnel from the National Data Buoy Center at NSTL, Mississippi, and the Naval Civil Engineering Laboratory at Port Hueneme, California, were contacted concerning the state-of-the-art in this type of technology. All parties agreed that the design project could involve a great deal of time and money if the above criteria cannot be relaxed. Preliminary configurations (e.g., spar buoy) were analyzed; however, the final design will depend upon the equipment shape. As of this writing, the equipment is still in the bid process.

Edwin Russo conducted a seminar on Ocean and Coastal Engineering. The talk included presentations on subjects which were pertinent to the Navy, such as (1) hurricanes, (2) storm surge, (3) tidal analysis, and (4) offshore structures.

Research Colleagues at NORDA: K. Smits, E. Mozley, and W. Avera

(Russo, 1988)

MARINE CABLE STRUMMING AND NAVIGATION STUDIES

Edwin P. Russo

Mechanical Engineering
University of New Orleans
New Orleans, Louisiana

Abstract

A document entitled "State of the Art in Marine Cable Strumming Technology" was prepared for submission as a NORDA Report. This paper outlined the latest advances (experimental, theoretical, and computational) in the study of vortex shedding from a cable (i.e., strumming). It is anticipated that strumming may cause problems in the cable array studies that are currently being conducted by NORDA. Navigation techniques for cable arrays were investigated and coordinated with the Marine Physical Laboratory of the Scripps Institute of Oceanography at San Diego, California.

Preliminary investigations involving the automation of a large cable testing apparatus were initiated; however, the modification equipment did not arrive in time to conduct tests. Future test programs with this testing machine will provide invaluable data for NORDA's mission oriented work on Marine Towing Cables.

In addition to the above mentioned NORDA Report on strumming, the following seven technical papers were prepared for publication and for presentation:

1. "Wave Height Prediction Using Stokes' Second Order Theory," submitted the Journal of Applied Ocean Research.
2. "Wave Height Predictions Using Stokes' Higher Order Theories," abstract accepted for the Offshore Mechanics and Arctic Engineering Conference, Hague, Netherlands, April 2-7, 1989.
3. "Using Modern Electric Circuit Analysis Computer Programs to Solve Heat Transfer Problems," submitted to the Journal of Engineering Education.
4. "Using Modern Electric Circuit Analysis Computer Programs to Solve Nonlinear Vibration Problems," to be submitted to the Journal of Sound and Vibration.
5. "Using the Electric Circuit Simulator SPICE to Analyze Towed Marine Cables," to be submitted to the Twelfth Canadian Congress of Applied Mechanics, Ottawa, Canada, May 28 - June 2, 1989.
6. "Using Modern Electric Circuit Analysis Computer Programs to Solve Mechanical Engineering Problems," to be submitted to the Twelfth Canadian Congress of Applied Mechanics, Ottawa, Canada, May 28 - June 2, 1989.
7. "Using the Electric Circuit Simulator SPICE to Analyze Nonlinear Vibration Problems," to be submitted to the Journal of Sound and Vibration.

Research Colleagues at NORDA: R. Young, M. Fagot, C. Orr, J. Elkins, R. Trahan

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(Russo, 1989)

ARRAY ELEMENT LOCATION

Edwin P. Russo

Mechanical Engineering Department
University of New Orleans
New Orleans, Louisiana

Abstract

Navigation techniques for marine cable arrays were investigated and coordinated with the Marine Physical Laboratory of the Scripps Institute of Oceanography at San Diego, CA. Computer programs for the surveying/localization of transponders were analyzed to determine the optimum procedure for precisely locating transponders. Computer programs to navigate the elements on an array using these transponders were studied. Interrogation sequence schemes for the transponder net were developed. These schemes included interrogation of the net from two sources without causing signal interference from the various transponders. Ray tracing programs were utilized. Preparation for analysis of array element location data from a Pacific Ocean Experiment was initiated. This work will continue throughout the year.

The following technical papers which were prepared during the past ASEE/Navy Summer Faculty Research Program were published and/or presented. Travel funds were not available from ASEE/Navy; however, the University partially funded the travel.

1. "Wave Height Prediction Using Stokes' Second Order Theory," published in the Hydrographic Journal, April 1989.

2. "Wave Height Predictions Using Stokes' Higher Order Theories," Offshore Mechanics and Arctic Engineering Conference, April 2-7, 1989; travel funds not available.

3. "Using the Electric Circuit Simulators SPICE to Analyze Towed Marine Cables," presented/published Twelfth Canadian Congress of Applied Mechanics, Ottawa, Canada, May 28-June 2, 1989; travel funds from University of New Orleans and personal funds.

4. "Using Modern Electric Circuit Analysis Computer Programs to Solve Mechanical Engineering Problems," presented/published Twelfth Canadian Congress of Applied Mechanics, Ottawa, Canada, May 28-June 2, 1989; travel funds from University of New Orleans and personal funds.

5. "State of the Art in Marine Cable-Strumming Technology," NORDA Technical Note 373, December 1988.

Research Colleague at NORDA: R. Young

(Sengupta, 1990)

CLOUD CLASSIFICATION IN POLAR REGIONS BASED ON TEXTURAL/SPECTRAL SIGNATURES USING AVHRR DATA

Sailes K. Sengupta

Department of Mathematics & Computer Science
South Dakota School of Mines & Technology
Rapid City, South Dakota

Abstract

In polar regions, cloud detection is a serious problem due to similarity in cloud and ice spectral signatures in both visible and infrared (IR) wavelengths. To improve the classification accuracy, we have included several textural features along with the spectral signatures derived from both visible and infrared channels. Our earlier texture-based algorithms showed good classification accuracy using high resolution Landsat MSS data. The present study uses a much lower resolution (1 Km.) AVHRR data. In this we have used channels (cosine-corrected) 1, 3-4, and 4 for deriving the textural/spectral signatures for the purpose of cloud classification. We have used two different methods: (a) The Stepwise Discriminant Analysis (SDA), and (b) Neural Network (NNW) Based (a feedforward network with backpropagation of error as the learning algorithm). In both cases the overall classification accuracy has been very good with NNW performing slightly better.

In all, 281 spectral/textural features and 11 classes of regions (including different classes of clouds and backgrounds typically found in a polar scene) have been considered. Of these features, between 20 to 25 features were selected first, using a sequential forward selection method based on a class separability measure for a given subset of features. These features, computed for a subset of the available samples were then input to the respective classifiers to train them. The trained classifiers were then used to classify an independent set of samples to evaluate the classification accuracy. Our preliminary results indicate an accuracy of between 85 to 89 per cent.

Research Colleague at NOARL: P. Tag

(Trahan, 1987)

THE NEED FOR THE DEVELOPMENT OF THE ACOUSTIC UNDERSEA ENVIRONMENTAL DATA ACQUISITION AND TRANSMISSION SYSTEM (ACUEDATS)

Russell E. Trahan, Jr.

Electrical Engineering Department
University of New Orleans
New Orleans, Louisiana

Abstract

The need for more accurate oceanographic information on a real-time basis by the U.S. Navy is well-documented. Therefore, a feasibility study was undertaken to determine if a new concept of an intelligent, profiling, free-drifting buoy referred to as the Acoustic Underwater Environmental Data Acquisition and Transmission System (ACUEDATS) should be developed. The conclusion is that there is a definite need to support new Navy Acoustic Performance Prediction (APP) systems with ACUEDATS. This study has shown that using currently available technology, ACUEDATS can be developed as a relatively low-risk project. A complete evaluation of the support provided by ACUEDATS to other Navy activities is provided in a classified document which will soon be available. This technical report will include details of the system design, the need for and benefits of the system, and an estimate of development time and cost.

Research Colleague at NORDA: R. Holland

(Trahan, 1988)

AN INTELLIGENT DATA SELECTION SYSTEM (IDSS)

Russell E. Trahan, Jr.

Electrical Engineering Department
University of New Orleans
New Orleans, Louisiana

Abstract

A conceptual design of an Intelligent Data Selection System (IDSS) has been completed. The basic premise of IDSS is the use of a multiprocessor environment for in situ processing of environmental data in order to avoid the storage of every data point. Environmental sensor outputs are first sampled and then categorized according to the most recent behavior of the signals. Once categorized, the data are queued for processing by individual microprocessors, referred to as compaction processors. Data compaction algorithms, such as statistical values, histograms, Fast Fourier Transforms, etc., are contained in the compaction processors. Once compacted, the data are stored in a mass storage device.

A software simulator of an IDSS system written for a VAX computer has indicated that a queuing scheme between a categorizer processor and the compaction processors via a processor called the arbitrator allows large amounts of data to be processed without loss of information. A hardware survey has been completed and a suggested design for an IDSS prototype is the result. In this proposed design, interprocessor communication is accomplished with dual-port RAM integrated circuits. The latter allow large blocks of data or messages to be passed from processor to processor very quickly and easily.

Based on this study, it has been concluded that much longer on station times for sensor systems is possible through the implementation of an IDSS.

Research Colleague at NORDA: R. Holland

(Trahan, 1989)

A VIDEO TELEMETRY SYSTEM FOR DEEP OCEAN USE

Russell E. Trahan, Jr.

Electrical Engineering Department
University of New Orleans
New Orleans, Louisiana

Abstract

A video system for use in deep ocean areas has been designed and prototyped. The basic specifications for the system include the need for a single coaxial cable to be used for towing the camera sled, and the transmission up the cable of video images at as near real time as possible. Much of the hardware and software used came from existing systems. This includes the underwater camera systems and pressure vessels, the coaxial cable, and the surface computer.

The underwater electronics system includes high grade commercial video cameras, an IBM PC compatible computer, and a frame-grabber board. The latter is a PC compatible board which is capable of taking an image from a video source and storing the image digitally in a 512 by 512 pixel array with eight bit resolution per pixel. The surface electronics has the same complement as the underwater unit, except that it is used to receive the images and display them on a high resolution monitor.

The uniqueness of this system is in the capability of sending a video signal with a bandwidth of 700 Khz over a cable which has a 65 Db loss at 1 Mhz. Also, it is necessary to send a 300 volt DC voltage down the cable in order to provide power to the underwater electronics. A vestigial sideband modulation method is used to transmit the video signal with an 800 Khz carrier. The cable itself and a surface equalizer are used to attenuate the upper sideband sufficiently in order to recover the video signal with an envelope detector at the surface. The latter includes a unique sample-hold circuit which effectively provides full wave rectification of the modulated carrier with a high bandwidth.

Video signals have been sent over a 9 km coaxial towing cable at the rate of seven frames per second with very good quality. The system also includes frequency-shift-keying (FSK) commands which can be sent from the surface to the underwater package and vice versa. This capability allows simultaneous transmission of video signals and the ability to change cameras, turn on underwater spotlights, etc.

Research Colleague at NORDA: R. Holland

INTERNAL TIDES IN GIBRALTAR STRAIT

Dong-Ping Wang

Marine Sciences Research Center
State University of New York
Stony Brook, New York

Abstract

A three-dimensional primitive-equation model is used to simulate the internal tidal wave in the Strait of Gibraltar. The model is driven by external tidal volume fluxes at model's open ocean boundaries and an initially separated two water mass of north Atlantic and Mediterranean origins. For the case of a neap tide, internal tidal waves are small compared to the mean two-layered gravitational circulation. Hydraulic jumps, that is, rapid sloping of isopycnals, occur near Strait's two exits, the Spartell Sill on the west and Gates of Hercules on the east. The mean transport in each layer is about 1 Sverdrup (10^6 m^3/s). For the case of a spring tide, tidal currents are comparable with gravitational currents. Starting at low water, isopycnals at Carmarinal Sill rise gradually from 200m depth to the surface, in association with a westward moving current. However, the westward current abruptly reverses direction near high water. As the eastward currents accelerate, isopycnals rapidly drop back from the surface to the 200m depth. A strong, nonlinear internal tide is generated near the sill, and it propagates eastward at a speed of about 1 m/s.

Model simulations are consistent with data obtained during the Gibraltar Strait Experiment. In particular, prediction of the internal tidal wave agrees well with both in situ data and remotely sensed information. Model study indicates that generation of internal tides is caused by a hydraulic jump when the speed of eastward currents is larger than the speed of internal wave. It is feasible to operate model for real-time prediction of internal waves in the Strait of Gibraltar. Model also can be used to examine a wide range of internal tidal processes which bear similarity with those in the Strait of Gibraltar.

(Wang, 1990)

SIGNIFICANCE OF PORE WATER PRESSURE IN MARINE SEDIMENTS: MEASUREMENTS AND DERIVED PROPERTIES

Mian C. Wang

Department of Civil Engineering
Pennsylvania State University
University Park, Pennsylvania

Abstract

In addition to the hydrostatic pressure, excess pore water pressure in marine sediments may be included by wave action, sediment deposition, thermal and chemical gradients, biogenic gas production, and loading. Pore water pressure reduces the shearing strength of sediments and may cause slope failure, instability of sediment supported structures and other related engineering and geological problems. This research was undertaken to (1) examine the importance of pore water pressure with regard to the ability of seafloor with or without supported structures, (2) develop procedures for using the measured excess pore pressure dissipation data to derive sediment properties useful for stability analysis of marine sediments, and (3) formulate plans for research on soil-structure interaction problems for future collaboration with NOARL.

The research involved primarily a review of literature, discussions with the colleagues, and data analysis. The results of this research have documented the role of pore water pressure in the stability of wave-structure-sediment system. It has clearly shown the importance of future research studies of ambient and dynamic pore water pressure. Also, a practical approach for evaluating critical sediment properties for analysis of soil-structure interaction problems has been developed. Furthermore, plans for future collaborative research between the Pennsylvania State University and NOARL has been formulated.

Research Colleagues at NOARL: R. Bennett and H. Li

SPATIAL VARIATIONS OF TIME VARYING
MAGNETIC NOISE IN THE MISSISSIPPI GULF COAST

Charles T. Young

Department of Geological Engineering, Geology and Geophysics
Michigan Technological University
Houghton, Michigan

Abstract

Geological and hydrographical data were utilized to predict the spatial variation of natural time varying magnetic noise (TVMN). Computations show that the main effect of TVMN is contributed by changes in water depth. Spatial variations in land and sea bottom electrical conductivity are a secondary contribution. The noise is stronger where the water layer tapers to zero thickness at the shoreline, and at the break in the continental shelf. The total field of the TVMN is enhanced 10 to 20 percent in these regions. The vertical component of the TVMN rises from approximately zero to 20 to 50 percent of the horizontal field in these regions. The horizontal field changes by only +/- 2 percent across these transition zones. These computations were carried out with a program for computing the response of a two dimensional earth to incident plane waves. The program is generally used to predict the response to magnetotelluric measurements to a given geologic model.

New field measurements were made of deep earth conductivities. These measurements were made along a north-south line connecting Gulfport and Wiggins, Mississippi. The magnetotelluric (MT) equipment was manufactured by Phoenix Geophysics of Toronto, Canada, and is owned by Michigan Technological University. The number of stations occupied was limited by time available and by bad weather (thunderstorms). The conductivity soundings obtained were compared to induction conductivity logs obtained from oil well drilling records, and to a sounding conducted at Dauphin Island, Alabama, by Mobil Oil. The results of the new measurements show conductivities very similar to the well log data and the Mobil MT sounding. The good agreement with the well log data suggests that log data, when available, can be used to construct earth models for the estimation of TVMN. The new data have been used to refine the two-dimensional model to more accurately compute the spatial variation of TVMN.

Research Colleagues at NOARL: E. Mozley and W. Avera

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Monterey, CA 93943-5006

Dr. Anthony Bedford
University of Texas at Austin
Department of Engineering and
  Engineering Mechanics
Austin, TX 78712-1085

Dr. Clyde J. Bergeron
University of New Orleans
Department of Physics
New Orleans, LA 70148

Dr. Peter A. Braza
University of North Florida
Department of Mathematics and
  Statistics
Jacksonville, FL 32216

1

Dr. E. Alan Dean
University of Texas at El Paso
Department of Physics
El Paso, TX 79968

Dr. Walter Drost-Hansen
University of Miami
Department of Chemistry
Laboratory for Water Research
Coral Gables, FL 33124

Dr. Richard E. Dubroff
University of Missouri at Rolla
Department of Electrical Engineering
214 Electrical Engineering Building
Rolla, MO 65401

Dr. Michael J. Duggin
State University of New York
Department of Forest Engineering
308 Bray Hall, CESF
Sryacuse, NY 13210

Dr. Richard W. Faas
Lafayette College
Department of Geology
Easton, PA 18042

Dr. William E. Full
The Wichita State University
Department of Geology
Wichita, KS 67208-3140

Dr. Lou Allen B. Gray
Jackson State University
Department of Mathematics
1300 Lynch Street
Jackson, MS 39217

Dr. Ronald L. Greene
University of New Orleans
Department of Physics
New Orleans, LA 70148

Dr. Shieh-Tsing Hsieh
Tulane University
Department of Electrical Engineering
New Orleans, LA 70118-5674

Dr. George E. Ioup
University of New Orleans
Department of Physics
New Orleans, LA 70148

Dr. Juliette W. Ioup
University of New Orleans
Department of Physics
New Orleans, LA 70148

Dr. O. John Jacobus
Tulane University
Department of Chemistry
New Orleans, LA 70118

Dr. Rong-Sheng Jin
Florida Institute of Technology
Department of Physics and Space
  Sciences
Melbourne, FL 32901

Dr. Robert R. Leben
University of Colorado
Department of Aerospace Engineering
  Sciences
Boulder, CO 80309

Dr. Lonzy J. Lewis
Jackson State University
Department of Physics and
  Atmospheric Sciences
1300 Lynch Street
Jackson, MS 39217

Dr. Allen E. Leybourne, III
University of Southern Mississippi
Department of Engineering Technology
Hattiesburg, MS 39406

Dr. Andrew B. Martinez
Tulane University
Department of Electrical Engineering
New Orleans, LA 70118

Dr. Kenneth C. Messa
Loyola University
Department of Mathematical Sciences
6363 St. Charles Avenue
New Orleans, LA 70118

2

Dr. A. Woodruff Miller
Brigham Young University
Department of Civil Engineering
Provo, UT 84602

Dr. Joseph E. Murphy
University of New Orleans
Department of Physics
New Orleans, LA 70148

Dr. William D. Philpot
Cornell University
Department of Civil and
  Environmental Engineering
Ithaca, NY 14853

Dr. Kewal K. Puri
University of Maine
Department of Mathematics
Orono, ME 04469

Dr. Robert D. Purrington
Tulane University
Department of Physics
New Orleans, LA 70118

Dr. Grayson H. Rayborn, Jr.
University of Southern Mississippi
Department of Physics and
  Astronomy
Southern Station Box 5165
Hattiesburg, MS 39406-5165

Dr. Richard Rezak
Texas A&M University
Department of Oceanography
College Station, TX 77843

Dr. Edwin P. Russo
University of New Orleans
Department of Mechanical Engineering
New Orleans, LA 70148

Dr. Sailes K. Sengupta
South Dakota School of Mines & Technology
Department of Mathematics &
  Computer Science
501 E. Street Joe
Rapid City, SD 57701

Dr. Russell E. Trahan, Jr.
University of New Orleans
Department of Electrical Engineering
New Orleans, LA 70148

Dr. Dong-Ping Wang
State University of New York
  at Stony Brook
Marine Sciences Research Center
Stony Brook, NY 11794

Dr. Mian C. Wang
Pennsylvania State University
Department of Civil Engineering
212 Sackett Building
University Park, PA 16802

Dr. Charles T. Young
Michigan Technological University
Department of Geological Engineering,
  Geology and Geophysics
Houghton, MI 49931

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